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Adaptation of Peppermint Grown on Egyptian Degraded Soils

Fatma R. Ibrahim[1]; M. A. El-Sherpiny[2*] and Dina A. Ghazi[3]

[1]Vegetable and ornamental plants Dept. Fac. Agric., Mansoura University, Mansoura, 35516, Egypt
[2]Soil & Water and Environment Research Institute, Agriculture Research Centre, Giza, 12619 Egypt
[3]Soils Dept. Fac. Agric., Mansoura University, Mansoura, 35516, Egypt

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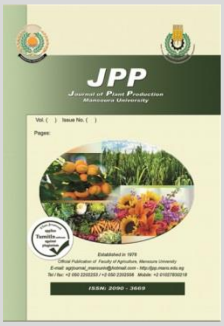

ABSTRACT

Peppermint *Mentha piperita* "Lamiaceae" is an aromatic plant has a strong sweetish odour used to add flavour or fragrance to foods in addition to its medicinal uses. Currently, the interest in expanding its cultivation in Egypt is considered necessary. Therefore, a nutritional experiment (Lysimeter trial) was executed under a split-plot design aiming to investigate the effect of foliar spraying methionine (50 mgL^{-1}) and melatonin (50 mgL^{-1}) plus control treatment on the peppermint grown on different soils *i.e.,* alluvial, sandy, calcareous and saline soils. The soil type represented the main factor, while the foliar applications were devoted to sub-plots. Growth criteria *i.e.,* plant height (cm), No. of leaves, fresh and dry weights (g $plant^{-1}$& Mg h^{-1}, 1.0 Mg ″mega gram″=10^6 g *i.e.,* metric ton) and essential oil (%) were measured at the first and second cut times. While, photosynthetic pigments *i.e.,* chlorophyll (mg g^{-1} F.W) and carotene (mg g^{-1}F.W) and quality traits *i.e.,* carbohydrates (%) and vitamin C (mg $100g^{-1}$) were determined at the second cut time only. The values of all aforementioned traits indicated that peppermint cultivation thrived in sandy soil followed by alluvial soil, while its performance was low under both calcareous and saline soils conditions, respectively. Regarding foliar applications, the methionine treatment was superior compared to melatonin, while the control treatment came in the last order. Generally, it can be concluded that the foliar spraying of both methionine and melatonin can improve the performance of peppermint grown on different soils, including degraded soils *e.g.,* calcareous and saline.

Keywords: Aromatic plant, sandy, alluvial, calcareous, saline

INTRODUCTION

Peppermint (*Mentha piperita*) is a perennial evergreen herbaceous plant with a creeping or upright growth nature. It belongs to the family of Lamiaceae (Labiateae) (Sharaf *et al.*, 2013). It is a well-known herb dating back thousands of years. The ancient Greeks, Romans, and Egyptians used it. The ancients knew the many benefits of peppermint and its various uses, and the use of peppermint is still popular to treat many diseases and health problems (Abdou and Mohamed, 2014). Peppermint is a popular drink in many countries, and the volatile oil is used in the food and pharmaceutical industries. It is also used in folk medicine to aid digestion, as a colic remover, and as a carminative (Trevisan *et al.*, 2017). Peppermint is rich in nutrients *e.g.,* iron, manganese as well as vitamin C and A, and folic acid. peppermint contains menthol as a main ingredient (50-60%), in addition to limonene, menthone, cineole, linalool and other ingredients (Cappellari *et al.*, 2020). Also, peppermint is rich in protecting antioxidants against many diseases, as these antioxidants are the reason behind the benefits of peppermint for the heart and the prevention of cancer and other diseases such as Alzheimer's (Alavi *et al.*, 2020).

Methionine is one of the vital amino acids, which collaborate in a variety of physiological functions (Hesse and Hoefgen, 2003). It is a tremendous regulator of plant growth and development under environmental stress conditions (Amir, 2008). It is one of 9 critical amino acids in humans, as it could be safely added to food (Amir *et al.*, 2019). It regulates transpiration, maintains membrane stability and relative water content, increases protein synthesis and photosynthetic rates, enhances enzyme activities and reduces free radical's production, H_2O_2 and MDA contents (EL-Bauome *et al.*, 2022).

Melatonin is a natural product found in plants. It is a hormone that plays a vital role in protecting the photosynthetic apparatus by enhancing the scavenging efficiency of free radicals and decreasing oxidative damage (Arnao *et al.*, 2006). It regulates stomatal motion, maintains cell membrane integrity (Tan *et al.*, 2012), enhances antioxidant enzyme activities, and controls the activity and production of core organic chemical compounds *e.g.,* proteins, chlorophyll and nitrogen-related molecules (Arnao *et al.*, 2015).

There is no doubt that the trend towards reclaiming degraded soils such as sandy, calcareous and saline soils has become a complementary and urgent necessity, as these soils are added to the fertile areas of the Delta and the Old Valley so that the state can confront the large gap between production and demand. Therefore, the final goal of this search was to assess the effect of foliar spraying methionine and melatonin on the peppermint grown on different soils.

MATERIALS AND METHODS

- Experimental Setup.

A nutritional experiment (Lysimeter trial) was executed in private farm (31° 3′ 16.2″ N, 31° 22′ 30″ E) during two successive seasons of 2020/2021 and 2021/2022 under a split plot design aiming to investigate the effect of foliar spraying methionine (50 mg L-1) and melatonin (50 mg L-1) plus control treatment (without) on the peppermint grown on different soils i.e., alluvial, sandy, calcareous and

*** Corresponding author.**
E-mail address: M_elsherpiny2010@yahoo.com

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saline soils. The soil type represented the main factor, while the foliar applications were devoted to sub-plots.

Uniform cuttings of peppermint plants were taken from symmetry mother plants and cultivated in a private nursery for rooting on 13th Oct, 2020 and 2021 seasons. The seedlings were transplanted on 18th Feb in irrigated lysimeters.

The execution of this research trial was implemented using 24 lysimeters (4 soil types x 2 foliar applications x 3 replicates), as lysimeter area was 1.0 m2 (1.0 m length x 1.0 m width with 0.75 m depth). Before transplanting, all lysimeters received compost at a rate of 10 m3 fed-1 + calcium superphosphate (6.6%P) at a rate of 300 kg fed.-1 + agricultural sulfur at a rate of 50 kg fed.-1. All lysimeters received mineral NK fertilizers at the recommended rates of the Ministry of Agri. and Soil Rec. (MASR), Egypt. Ammonium sulfate (20.6 % N), was added at a rate of 400 kg fed-1 during the growing season in four equal doses with a one-month interval between each batch. While potassium sulphate (39.8 % K) was added at a rate of 150 kg fed.-1 during the growing season in three equal doses.

Both melatonin and methionine were purchased from the Egyptian commercial market, where the external application was repeated 6 times with 15 days intervals starting from 15th march until 15th June. Also, the external application was repeated twice with 15 days intervals starting from 15th July.

In both studied seasons, the peppermint was harvested twice by cutting the aerial parts of each plant with a height of 10 cm above the soil surface. The first cut was carried out in the 3rd week of June, while the second cut was done in the 3rd week of September. Four plants were randomly chosen from each lysimeter at each cut,in both seasons.

- Soil Sampling.

The samples of the studied soils before putting them in the used lysimeters were analyzed. Their characteristics are shown in Table.1.

Table 1. Characteristics of initial soils studied

Soil types / Characteristics	Sandy	Alluvial	Calcareous	Saline	Methods	References
Sand,%	91.0	22.00	57.5	15.9	Using pipette method	Gee and Baudet, (1986)
Silt,%	3.00	27.10	25.3	30.1		
Clay,%	6.00	50.90	17.2	54.0		
Texture class	Sandy	Clay	Sandy loam	Clay	Using soil texture triangle	
EC, dSm^{-1}	1.10	2.50	3.50	6.23	Using EC- meter	Dewis and Freitas, (1970)
pH (1:2.5 soil suspension)	7.80	8.10	8.40	7.95	Using pH- meter	
$CaCO_3$, %	1.10	2.70	14.5	1.90	By Walkly and Balck method	
OM (organic matter),%	0.25	1.٦5	0.50	1.٥0	Using calceimeter	

- Measurements

1. Vegetative growth criteria and oil yield

Growth criteria *i.e.,* plant height (cm), No. of leaves, fresh and dry weights (g $plant^{-1}$& Mg h^{-1}, 1.0 Mg ″mega gram″=10^6 g *i.e.,* metric ton) and essential oil (%) were measured at the first and second cut times. Essential oil (%) was determined in the dried samples by subjecting peppermint leaves (100 g) to hydrodistillation in Clevenger apparatus according to the method described by British Pharmacopoeia (2000).

2.Photosynthetic pigments and quality parameters

Photosynthetic pigments *i.e.,* chlorophyll [mg g-1 F.W, according to Sadasivam and Manickam, (1996)] and carotene [mg g-1F. W, according to Ranganna, (1997)] as well as quality traits *i.e.,* carbohydrates [%, Cipollini Jr *et al.*, (1994)] and vitamin C[mg 100g-1, Mazumdar and Majumder, (2003)] were determined at the second cut time only.

- Statistical Analysis.

The obtained Data was statistically analyzed according to Gomez and Gomez, (1984).

RESULTS AND DISCUSSION

- Growth criteria and oil yield

Data of growth criteria *i.e.,* plant height (cm), No. of leaves, fresh and dry weights (g $plant^{-1}$& Mg h^{-1}, 1.0 Mg ″mega gram″=10^6 g *i.e.,* metric ton) and essential oil (%) as influenced by different soil type and foliar application at the first and second cut times during seasons of 2020/2021 and 2021/2022 for two cuts (combined data over both seasons) are presented in Tables 2 and 3.

Table 2. Effect of foliar spraying methionine and melatonin on growth criteria of *Mentha piperita* L. plants grown on different soil types during seasons of 2020/2021 and 2021/2022 for two cuts (combined data over both seasons)

Treatments		Plant height, cm		No. of leaves		Fresh weight, g $plant^{-1}$		Dry weight, g $plant^{-1}$	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
Soil types									
Alluvial		50.41b	44.37b	110.33b	194.22b	55.14b	95.31b	17.70b	25.74b
Sandy		52.53a	46.30a	115.44a	199.56a	58.63a	101.63a	18.19a	27.32a
Calcareous		45.48c	39.76c	97.56c	181.67c	47.14c	80.84c	16.64c	21.94c
Saline		40.17d	34.63d	85.89d	172.67d	38.92d	66.88d	15.29d	18.80d
LSD at 5%		0.41	0.37	0.85	1.13	0.24	0.96	0.05	0.05
Foliar application									
Control (without)		45.13b	39.25c	97.00c	182.50c	46.58c	80.50c	16.44c	22.06c
Methionine		48.28a	42.54a	105.83a	190.00a	52.14a	89.59a	17.26a	24.42a
Melatonin		48.04a	42.00b	104.08b	188.58b	51.16b	88.41b	17.16b	23.87b
LSD at 5%		0.66	0.53	1.29	1.09	0.23	0.78	0.07	0.10
Interaction									
Alluvial	Control (without)	48.60d	42.47e	104.33e	189.33d	51.69f	89.20f	17.19f	24.24f
	Methionine	51.90b	45.90c	115.33b	197.67c	57.92c	100.24v	18.10c	26.94c
	Melatonin	50.73bc	44.73d	111.33c	195.67c	55.81d	96.49d	17.81d	26.04d
Sandy	Control (without)	49.87cd	43.53e	108.67d	190.67d	53.72e	92.76e	17.53e	25.12e
	Methionine	53.97a	48.27a	120.33a	205.33a	62.14a	108.14a	18.70a	28.93a
	Melatonin	53.77a	47.10b	117.33b	202.67b	60.03b	104.00b	18.35b	27.91b
Calcareous	Control (without)	44.03g	38.20h	94.67h	179.67f	44.88i	76.69i	16.35i	20.88i
	Methionine	46.93e	41.30f	100.33f	184.67e	49.40g	84.98g	16.94g	23.03g
	Melatonin	45.47f	39.77g	97.67g	180.67f	47.14h	80.86h	16.64h	21.91h
Saline	Control (without)	38.00j	32.80k	80.33k	170.33h	36.01l	63.35l	14.71l	18.01l
	Methionine	40.30i	34.70j	87.33j	172.33h	39.09k	65.02k	15.31k	18.77k
	Melatonin	42.20h	36.40i	90.00i	175.33g	41.67j	72.28j	15.85j	19.60j
LSD at 5%		1.31	1.08	2.52	2.19	0.46	1.56	0.14	0.20

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Table 3. Effect of foliar spraying methionine and melatonin on yield and essential oil of *Mentha piperita* L. plants grown on different soil types during seasons of 2020/2021 and 2021/2022 for two cuts (combined data over both seasons)

Treatments		Fresh weight yield, Mg h^{-1}		Dry weight yield, Mg h^{-1}		Essential oil, %	
		1st cut	2nd cut	1st cut	2nd cut	1st cut	2nd cut
			Soil types				
Alluvial		3.446b	5.957b	1.106b	1.609b	2.03b	1.81b
Sandy		3.664a	6.352a	1.137a	1.707a	2.12a	1.91a
Calcareous		2.946c	5.053c	1.040c	1.371c	1.77c	1.53c
Saline		2.433d	4.180d	0.956d	1.175d	1.59d	1.25d
LSD at 5%		0.015	0.060	0.003	0.003	0.01	0.02
			Foliar application				
Control (without)		2.911c	5.031c	1.028c	1.379c	1.78c	1.52c
Methionine		3.259a	5.600a	1.079a	1.526a	1.94a	1.66a
Melatonin		3.197b	5.525b	1.073b	1.492b	1.91b	1.69b
LSD at 5%		0.014	0.048	0.004	0.006	0.03	0.02
			Interaction				
Alluvial	Control (without)	3.231f	5.575f	1.074f	1.515f	1.92d	1.71e
	Methionine	3.620c	6.265c	1.131c	1.684c	2.12b	1.88c
	Melatonin	3.488d	6.031d	1.113d	1.628d	2.05c	1.83c
Sandy	Control (without)	3.358e	5.798e	1.096e	1.570e	1.97d	1.76d
	Methionine	3.884a	6.759a	1.169a	1.808a	2.23a	2.01a
	Melatonin	3.752b	6.500b	1.147b	1.744b	2.18a	1.95b
Calcareous	Control (without)	2.805i	4.793i	1.022i	1.305i	1.71g	1.45h
	Methionine	3.087g	5.311g	1.059g	1.440g	1.84e	1.52g
	Melatonin	2.946h	5.054h	1.040h	1.369h	1.77f	1.63f
Saline	Control (without)	2.251l	3.959l	0.920l	1.126k	1.53i	1.15k
	Methionine	2.443k	4.064k	0.957k	1.173j	1.59h	1.23j
	Melatonin	2.604j	4.518j	0.990j	1.225	1.64h	1.36i
LSD at 5%		0.029	0.097	0.008	0.012	0.05	0.05

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

The highest values of all aforementioned traits were achieved when peppermint was cultivated in sandy soil followed by alluvial soil then calcareous soil, while the peppermint grown on saline soil had the lowest ones. The same trend was found concerning both studied cuts.

Regarding foliar applications, the methionine treatment was superior for obtaining the highest values of plant height (cm), No. of leaves, fresh and dry weights (g plant-1& Mg h-1, 1.0 Mg) and essential oil (%) compared to melatonin, while the control treatment came in the last order. The same trend was found in the first cut time as well as in the second cut time.

Generally, it can be noticed there were significant differences, as the maximum values of parameters mentioned previously were realized with peppermint grown on sandy soil when it was sprayed with methionine amino acid. The obtained results were similar in the two cut times. In this respect, also it can be said that the essential oil (%) in the dried leaves of peppermint plants, as the most important component, varied from one soil type to another as well as from one application treatment to another (Table 3). The highest increase in oil percentage was obtained with plants grown on sandy soil and simultaneously sprayed with methionine.

Photosynthetic pigments and quality parameters

Data presented in Table 4 elucidate the effect of foliar spraying methionine and melatonin on photosynthetic pigments *i.e.*, chlorophyll (mg g^{-1} F.W) and carotene (mg g^{-1}F.W) and quality traits *i.e.*, carbohydrates (%) and vitamin C (mg $100g^{-1}$) of *Mentha piperita* L. plants grown on different soil types during seasons of 2020/2021 and 2021/2022 for the second cut only (combined data over both seasons).

The values of photosynthetic pigments and quality traits indicated that peppermint cultivation thrived in sandy soil followed by alluvial soil, while its performance was low under both calcareous and saline soils conditions, respectively.

Respecting exogenous applications, the methionine treatment came in the first order for obtaining the highest values of photosynthetic pigments and quality traits followed by the melatonin application, which came in the second order, while the control treatment came in the last order.

Concerning the interaction effect, the maximum values of parameters mentioned previously were achieved with peppermint grown on sandy soil when it was sprayed with methionine amino acid. The obtained results show that peppermint cultivation thrived in sandy soil and this may be attributed to its good aeration and good drainage as well as may be due to declining pH value compared to other soils type (Huang and Hartemink, 2020). Alluvial soil came in the second order and this may be due to its high content of nutrients and organic matter compared to other soils type (Šajn *et al.*, 2011). Both calcareous and saline soil came in the last orders, respectively and this is due to their known problems.

Calcareous soil is characterized by soil cohesion when dry, especially in the surface layer. Its high content of calcium carbonate negatively affects the validity of most nutrients in the soil. Fixation of some added nutrients, such as phosphorus, and the difficulty of absorbing them by the peppermint plant as a result of the presence of an excess stock of calcium ions in calcareous soil (Leytem and Mikkelsen, 2005). Also, calcareous soil is characterized by a deficiency of some trace elements such as iron (Chen and Barak, 1982). As for the problems of the studied salt-affected soil, they are represented in its high salt content either dissolved in the soil solution or exchanged on the soil particles (exchange complex). This may lead to the deterioration of soil properties and thus the deterioration of the growing peppermint under saline soil (Qadir *et al.*, 2000).

Therefore, it can be said that salinity and alkalinity stress is one of the most deleterious abiotic stress factors that affected peppermint growth performance and its physiology.

Table 4. Effect of foliar spraying methionine and melatonin on photosinthitic pigments and quality parameters of *Mentha piperita* L. plants grown on different soil types during seasons of 2020/2021 and 2021/2022 for the second cut (combined data over both seasons)

Treatments		Chlorophyll, mg g^{-1} F.W	Carotene, mg g^{-1} F.W	Carbohydrates, %	Vitamin C, mg 100g^{-1}
Soil types					
Alluvial		1.872b	0.398b	16.25b	21.20b
Sandy		1.926a	0.446a	16.83a	21.74a
Calcareous		1.686c	0.291c	14.67c	19.97c
Saline		1.466d	0.213d	13.34d	19.07d
LSD at 5%		0.031	0.006	0.04	0.30
Foliar application					
Control (without)		1.664c	0.294c	14.66c	19.97b
Methionine		1.779a	0.365a	15.65a	20.87a
Melatonin		1.769b	0.352b	15.50b	20.65a
LSD at 5%		0.019	0.004	0.06	0.24
Interaction					
Alluvial	Control (without)	1.804e	0.347f	15.60f	20.61ef
	Methionine	1.925b	0.439c	16.70c	21.69bc
	Melatonin	1.887c	0.408d	16.45d	21.31cd
Sandy	Control (without)	1.842d	0.378e	16.01e	20.92de
	Methionine	1.981a	0.492a	17.40a	22.37a
	Melatonin	1.954ab	0.468b	17.07b	21.92ab
Calcareous	Control (without)	1.624h	0.253i	14.25i	19.70hi
	Methionine	1.748f	0.321g	15.11g	20.27fg
	Melatonin	1.687g	0.299h	14.66h	19.93gh
Saline	Control (without)	1.383k	0.200l	12.79l	18.63k
	Methionine	1.464j	0.208k	13.40k	19.14j
	Melatonin	1.550i	0.232j	13.81j	19.44ij
LSD at 5%		0.037	0.008	0.12	0.47

Means within a row followed by a different letter (s) are statistically different at a 0.05 level

Salinity and alkalinity stress may impose a negative influence on peppermint plants' growth by inducing morphological and physiological changes, decreasing leaf water potential, production of free radicals or as known reactive oxygen species (ROS), increased ion toxicity, osmotic stress, and altering the biochemical processes (Jamil *et al*., 2012; Wei *et al*., 2015; Arif *et al*., 2020).

Under calcareous and saline soil, respectively, the production of ROS was higher than in sandy and alluvial soil and this might make them come in the last orders.

Both methionine and melatonin buffered the negative effect of both calcareous and saline soils by raising the plant's self-production of antioxidants and scavenging ROS.

The superiority of methionine may be due to being a tremendous regulator of plant growth and development under environmental stress conditions. In addition to its role in regulating transpiration, maintaining membrane stability and relative water content, increasing protein synthesis and photosynthetic rates, enhancing enzyme activities and reducing ROS, H_2O_2 and MDA contents (Amir *et al.,* 2019).

Also, melatonin plays a vital role in protecting the photosynthetic apparatus by enhancing the scavenging efficiency of free radicals and decreasing oxidative damage, but to a lesser extent than methionine. Generally, melatonin may regulate stomatal motion, maintains cell membrane integrity, enhances antioxidant enzyme activities, and controls the activity and production of core organic chemical compounds *e.g.,* proteins, chlorophyll and nitrogen-related molecules (Arnao and Hernandez-Ruiz, 2015).

The obtained results are in harmony with those of Haydari *et al.,* (2019) and EL-Bauome *et al.,* (2022).

CONCLUSION

From the obtained results, it was found that peppermint cultivation thrives in sandy soil followed by alluvial soil and then calcareous and saline soil, respectively. Also, the findings confirm that the foliar spraying of both methionine and melatonin can improve the performance of peppermint grown on different soils, including degraded soils *e.g.*, calcareous and saline. Noting that methionine is superior to melatonin.

Generally, it can be concluded that the presence of both methionine and melatonin in fertilization programs for peppermint grown either on fertile or degraded soils, will play a major role in improving sustainability, growth performance and productivity. Finally, the results of this research may open up other ways for us to continue the approach of maximizing peppermint productivity.

REFERENCES

Abdou, M. and Mohamed, M. A. H. (2014). Effect of plant compost, salicylic and ascorbic acids on *Mentha piperita* L. plants. Biological Agriculture and Horticulture, 30(2); 131-143.

Alavi, S. A.; Ghehsareh, A. M.; Soleymani, A.; Panahpour, E.and Mozafari, M. (2020). Pepermint (*Mentha piperita* L.) growth and biochemical properties affected by magnetized saline water. Ecotoxicology and Environmental Safety, 201, 110775.

Amir, R. (2008). Towards improving methionine content in plants for enhanced nutritional quality. Funct. Plant Sci. Biotechnol., 2(1): 36-46.

Amir, R.; Cohen, H. and Hacham, Y. (2019). Revisiting the attempts to fortify methionine content in plant seeds. J. of Experimental Botany, 70(16): 4105-4114.

Arif, Y.; Singh, P.; Siddiqui, H.; Bajguz, A. and Hayat, S. (2020). Salinity induced physiological and biochemical changes in plants: An omic approach towards salt stress tolerance. Plant Physiology and Biochemistry, 156: 64-77.

Arnao, M. B. andHernández-Ruiz, J. (2006). The physiological function of melatonin in plants. Plant Signaling and Behavior, 1(3): 89-95.

Arnao, M. B. and Hernández-Ruiz, J. (2015). Functions of melatonin in plants: a review. J. of Pineal Res., 59(2): 133-150.

British Pharmacopoea (2000). Determination of volatile oil in drugs. The Pharmaceutical press.London.pp.1914.

Cappellari, L. D. R.; Chiappero, J.; Palermo, T. B.; Giordano, W. and Banchio, E. (2020). Volatile organic compounds from rhizobacteria increase the biosynthesis of secondary metabolites and improve the antioxidant status in *Mentha piperita* L. grown under salt stress. Agronomy, 10(8), 1094.

Chen, Y. and Barak, P. (1982). Iron nutrition of plants in calcareous soils. Advances in Agronomy, 35: 217-240.

Cipollini Jr, D. F.; Newell, S. J and Nastase, A. J. (1994). Total carbohydrates in nectar of *Sarracenia purpurea* L.(northern pitcher plant). American Midland Naturalist, 374-377.

Dewis, J. and Freitas, F. (1970). Physical and chemical methods of soil and water analysis. FAO soils Bulletin, (10).

EL-Bauome, H. A.; Abdeldaym, E. A.; Abd El-Hady, M. A. M.; Darwish, D. B. E.; Alsubeie, M. S.; El-Mogy, M. M., ... & Doklega, S. M. (2022). Exogenous proline, methionine, and melatonin stimulate growth, quality, and drought tolerance in cauliflower plants. Agriculture, 12(9), 1301.

Gee, G.W. and Bauder, J.W. (1986). Particle-size Analysis. p 383-411 In A. Klute (ed.) Methods of Soil Analysis Part 1. Soil Science Society of America Book Series 5, Madison, Wisconsin, USA.

Gomez, K. A and Gomez, A. A. (1984). "Statistical Procedures for Agricultural Research". John Wiley and Sons, Inc. New York.pp:680.

Haydari, M.; Maresca, V.; Rigano, D.; Taleei, A.; Shahnejat-Bushehri, A. A.; Hadian, J., ... & Basile, A. (2019). Salicylic acid and melatonin alleviate the effects of heat stress on essential oil composition and antioxidant enzyme activity in *Mentha× piperita* and *Mentha arvensis* L. Antioxidants, 8(11), 547.

Hesse, H. and Hoefgen, R. (2003). Molecular aspects of methionine biosynthesis. Trends in Plant Science, 8(6): 259-262.

Huang, J. and Hartemink, A. E. (2020). Soil and environmental issues in sandy soils. Earth-Science Reviews, 208, 103295.

Jamil, M.; Bashir, S.; Anwar, S.; Bibi, S.; Bangash, A.; Ullah, F. and Rha, E. S. (2012). Effect of salinity on physiological and biochemical characteristics of different varieties of rice. Pak. J. Bot, 44(1): 7-13.

Leytem, A. B. and Mikkelsen, R. L. (2005). The nature of phosphorus in calcareous soils. Better Crops, 89(2): 11-13.

Mazumdar, B. C and K. Majumder (2003). Methods on Physico-Chemical Analysis of Fruits. Univ. Cokkege of Agric. Calcutta Univ., 108-109.

Qadir, M.; Ghafoor, A.and Murtaza, G. (2000). Amelioration strategies for saline soils: a review. Land Degradation & Development, 11(6): 501-521.

Ranganna, S. (1997). Plant pigment In: Handbook of analysis and quality control for fruits and vegetable products. Tata McGrew Hill Pub. Co Ltd. New Delhi. pp. 11-12.

Sadasivam, S. and Manickam, A. (1996). Biochemical Methods, 2nd Ed. New age inter. India.

Šajn, R.; Halamić, J.; Peh, Z.; Galović, L. and Alijagić, J. (2011). Assessment of the natural and anthropogenic sources of chemical elements in alluvial soils from the Drava River using multivariate statistical methods. J. of Geochemical Exploration, 110(3): 278-289.

Sharaf, E. D.; Fouda, R. A.; EL-Gamal, S. A. and Shalan, M. M. N. (2013). Effect of organic and bio-fertilizers on some quality and quantity characters of mentha piperita l. plants. J. of Plant Production, 4(3): 401-416.

Tan, D. X.; Hardeland, R.; Manchester, L. C.; Korkmaz, A.; Ma, S., Rosales-Corral, S. and Reiter, R. J. (2012). Functional roles of melatonin in plants, and perspectives in nutritional and agricultural science. J. of Experimental Botany, 63(2): 577-597.

Trevisan, S. C. C.; Menezes, A. P. P.; Barbalho, S. M. and Guiguer, É. L. (2017). Properties of *mentha piperita*: a brief review. World J. Pharm. Med. Res., 3(1): 309-313.

Wei, L. X.; Lv, B. S.; Wang, M. M.; Ma, H. Y.; Yang, H. Y.; Liu, X. L., ... & Liang, Z. W. (2015). Priming effect of abscisic acid on alkaline stress tolerance in rice (*Oryza sativa* L.) seedlings. Plant Physiology and Biochemistry, 90: 50-57.

تكيف النعناع الفلفلي المزروع في أراضي مصرية متدهورة

فاطمة رشاد إبراهيم[١] ، محمد عاطف الشربيني[٢] و دينا عبد الرحيم غازي[٣]

[١]قسم الخضر والزينة -كلية الزراعة – جامعة المنصورة -مصر.
[٢]معهد بحوث الأراضي والمياه والبيئة – مركز البحوث الزراعية – الجيزة – مصر
[٣]قسم علوم الأراضي -كلية الزراعة – جامعة المنصورة -مصر.

الملخص

النعناع الفلفلي هو نبات عطري له رائحة حلوة قوية يستخدم لإضافة نكهة أو رائحة للأطعمة بالإضافة إلى استخداماته الطبية. في الوقت الحالي، يعتبر الاهتمام بالتوسع في زراعته في مصر امرا ضروريًا. لذلك، تم تنفيذ تجربة غذائية (تجربة ليزوميترات) باستخدام التصميم التجريبي القطع المنشقة بهدف دراسة تأثير الرش الورقي للميثيونين (بمعدل ٥٠ مليجرام/ لتر) والميلاتونين (بمعدل ٥٠ مليجرام/ لتر) بالإضافة إلى معاملة الكنترول (بدون) على النعناع الفلفلي النامي بأراضي مختلفة مثل الأراضي الرسوبية والرملية والجيرية والملحية. كان نوع التربة يمثل العامل الرئيسي في التصميم التجريبي، بينما مثل الرش الورقي القطع المنشقة. تم قياس معايير النمو، مثل ارتفاع النبات (سم)، وعدد الأوراق، والأوزان الطازجة والجافة (جم /نبات & ميجا جرام / هيكتار، حيث ١,٠ ميجا جرام تعادل ١٠٦ جم او طن) والزيت العطري (٪) عند الحشه الاولي والثانية. بينما، تم قياس صبغات البناء الضوئي، مثل الكلوروفيل (ملجم/ جم، وزن طازج) والكاروتين (ملجم/ جم، وزن طازج) وكذلك صفات الجودة مثل الكربوهيدرات (٪) وفيتامين سي (مجم/١٠٠ جم) مع الحشة الثانية فقط. أشارت قيم جميع الصفات المذكورة اعلاه إلى أن زراعة النعناع الفلفلي تجود في الارض الرملية تليها الاراضي الرسوبية، بينما كان أداؤه منخفضًا تحت ظروف التربة الجيرية والملحية على التوالي. فيما يتعلق بالرش الورقي، كانت معاملة الميثيونين أفضل من الميلاتونين، بينما جاءت معاملة الكنترول في الترتيب الأخير. بشكل عام، يمكن استنتاج أن الرش الورقي لكل من الميثيونين والميلاتونين يمكن أن يحسن أداء النعناع النامي بالأراضي المختلفة، بما في ذلك الأراضي المتدهورة مثل الأراضي الجيرية والملحية.